GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION (404) 894-4820

Date: 12/5/80

Project Title: Electrochemical Concentration of Gaseous Sulfur Oxides in a Molten Salt Cell

Project No: E-19-626

Project Director: Dr. Jack Winnick

Sponsor: National Science Foundation; Washington, D. C. 20550

Agreement Period: From 9/15/80 Until 9/30/81
(Includes usual six (6) month unfunded flexibility period)

Type Agreement: Grant No. CPE-8020630

Amount: $45,000 NSF
921 GIT (E-19-350)
$45,921 TOTAL

Reports Required: Final Project Report

Sponsor Contact Person (s):

Technical Matters

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Directorate for Engineering and Applied Science

National Science Foundation
Washington, D. C. 20550
202/357-9606

Contractual Matters
(thru OCA)

Mr. Al Rice
NSF Grants Official
Section I
AAEO/EAS Branch

Division of Grants and Contracts
Directorate for Administration
National Science Foundation
Washington, D. C. 20550
202/357-9626

Defense Priority Rating: None

Assigned to: Chemical Engineering (School/~~Laboratory~~)

COPIES TO:

- Project Director
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- School/Laboratory Director
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CA–3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 11/1/83

Project No. E-19-626 School/~~Lab~~XXX Ch E

Includes Subproject No.(s) N/A

Project Director(s) Dr. Jack Winnick GTRI/~~GIT~~XXX

Sponsor National Science Foundation

Title Electrochemical Concentration of Gaseous Sulfur Oxides in a Molten Salt Cell.

Effective Completion Date: 9/15/80 (Performance) 9/30/81 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] ~~Final Invoice~~XXXXXXXXX Final Fiscal Report
- [ ] Closing Documents
- [X] Final Report of Inventions if positive
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. N/A

Continued by Project No. N/A

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Form OCA ~~58-1804~~

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Tech	Chem. & Biochem. Proc.	ENG 8020630 (CPE)
	4. Award Period From 9/15/80 To 9/30/81	5. Cumulative Award Amount $45,000

6. Project Title
Electrochemical Concentration of Gaseous Sulfur Oxides in a Molten Salt Cell

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

See attachment.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (√)	Approx. Date
a. Abstracts of Theses			✓		
b. Publication Citations		✓			
c. Data on Scientific Collaborators	✓				
d. Information on Inventions		✓			
e. Technical Description of Project and Results			✓		
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Jack Winnick		7/24/81

NSF Form 98A (5-78) Supersedes All Previous Editions

Form Approved OMB No. 99R01

II. Summary -- NSF ENG 7810828/8020630

An electrochemical device was conceived to remove sulfur oxides from low levels in streams such as flue gas.* The process, as conceived, operates as a concentration cell utilizing a molten salt electrolyte. The product would be concentrated SO_3 if operated with power input, or elemental sulfur if operated as a fuel cell with reducing-gas supplied. Since this is an entirely new concept, many areas needed exploration. First, the electrochemical reactions needed verification. Second, materials for the electrolyte, supporting matrix and electrodes needed identification. Half-cell tests were necessary to determine thermodynamic and rate parameters. Finally, full-cell tests would verify design concepts.

Thermodynamic analysis quickly identified the reactions:

$$SO_2 + O_2 + 2e \rightarrow SO_4^{2-} \qquad \text{cathode}$$

and

$$SO_4^{2-} \rightarrow SO_3 + 1/2\ O_2 \qquad \text{anode}$$

as desireable and expected with a sulfate electrolyte. The lowest melting, stable eutectic was found to be $(Li, K, Na)_2\ SO_4$ (512C). All experiments used this eutectic. The support matrix was first chosen as MgO due to its tile-forming capability. Later, $LiAlO_2$ replaced MgO due to its successful use in the molten carbonate fuel cell program. Choice of electrode materials was the most difficult. Thermodynamics showed no non-noble metal to be stable. It was hoped some might form a stable, passive oxide form. Experiments were negative. However, a ceramic material has proven very stable, both chemically and physically.** Its conductivity, at temperature, is equivalent to metallic materials.

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*U.S. Patent No. 4246081, January 1981.

**X-ray diffraction and scanning-electron-microscopy were used in this analysis -- performed prior to and after long-term tests.

The half-cell studies showed that the proposed reactions occur as expected in free electrolyte. Futher, as expected, high concentrations of CO_2, as found in flue gas, have insignificant effect. Full-cell tests with the ceramic electrodes have only just begun. They are however, very encouraging.[+] The economics projected for a full-size device appear highly favorable. Installed costs would be about one-third existing technology. Operating costs would likewise be about one-third. No reagents would be required and the only output would be concentrated sulfuric acid (>100%).[+]

[+]Townley, Dan and J. Winnick, I. and E.C. Proc. Des. Dev., 20, 435, 1981.